CEMENT
AND
CEMENT MANUFACTURE

INCORPORATING "PORTLAND CEMENT"

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"Cement and Cement Manufacture."

WITH this number "CEMENT & CEMENT MANUFACTURE" starts its career as a separate journal. First published as a supplement to "Concrete and Constructional Engineering" in September last year, it met with immediate success. A very large number of letters of appreciation have reached us from those prominently connected with the cement industry and from firms catering for the industry, confirming our opinion that a British journal devoted to cement manufacture was long overdue and badly needed. There are, of course, excellent cement journals published abroad, but as practically the whole of their contents relates to the practice in the countries of their origin their use to the British manufacturer has been limited. "CEMENT & CEMENT MANUFACTURE" is published primarily to promote the interests of the British cement industry; to disseminate knowledge of new theories and processes; to keep its readers up-to-date with current British practice and developments the world over; to inform those interested of new methods and plant and other means of improving quality and reducing costs.

No pains or expense will be spared in making this journal of real value to its readers; the staff of acknowledged experts already writing for "CEMENT & CEMENT MANUFACTURE" is sufficient guarantee that a reliance on "scissors-and-paste" abstracts from matter already published elsewhere will take no part in the compilation of this journal. Strange as it may seem in these days when periodicals appear to be published with the primary object of attracting advertisements without regard to the interests of the reader, we think those familiar with other journals published by Concrete Publications, Limited, need no telling that to present month by month the best possible Editorial matter is our first concern.

To this end we would welcome suggestions for new features that would be valuable, and invite those with special knowledge to submit articles for publication.

Dry and Wet Processes in Portland Cement Manufacture.

By HENRY POOLEY, B.Sc., A.M.Inst.C.E., A.M.I.Mech.E., F.C.S.

THE leading article in "Cement and Cement Manufacture" for October reviews the relative merits of the dry and wet processes for Portland cement manufacture. This is an important question, and no apology is needed for adding a few words, perhaps not always in agreement, to this article.

As indicated, in the dry process the raw materials for cement manufacture are ground and proportioned in the dry state, and are introduced into the kiln with an addition of up to 10 per cent. of water In the wet process water is added to the raw materials when they are ground. In this case the raw materials are finally proportioned in what might be termed a liquid form, and are introduced into the kiln in this state. The slurry may contain anything between 32 per cent. and 45 per cent. or more of water, depending upon the nature of the raw materials and the efficiency of the plant.

To the layman the fact of adding water when grinding to materials already dry, and then evaporating this water in the kiln, naturally suggests a bias in favour of the dry plant, but there are other considerations. In this country the question rarely arises, because most of the materials from which cement is made are of such a nature that difficult and costly drying would be necessary to prepare them for the dry process, and it is this reason which has given pre-eminence to the wet process in Great Britain. But in America, where raw materials often exist in a very dry state, the dry process has become important. In India, Africa, China, and elsewhere, the materials are frequently found in a similar dry state.

In these days it is vital to manufacture a cement which is absolutely uniform in quality. To do this, it is necessary to have the best possible control over the proportioning of the raw materials to ensure that the mixture entering the kiln is always constant in composition. In the wet process, where the materials are carried by water, it is easier to obtain a uniform composition throughout a quantity of the material than in the dry process, where these raw materials are in the powdered form. Unless an elaborate system of bins, conveyors and elevators, or pumps is installed, the variation in composition of the mix entering the kiln in the dry system may be considerable. Even with an elaborate bin system, and if the powder is extracted from a silo and returned to the same or some other silo by means of Fuller-Kenyon pumps, it can hardly be possible to maintain the same uniformity as with slurry. At least such a system will be more difficult to control and more liable to error when using the semi-skilled labour which it is only possible to obtain in some places.

It may be stated that, while constancy of composition can be maintained with ease and regularity in the wet process, it is more difficult to obtain the same result in the dry system. These considerations naturally have an effect upon the quality of the cement, and therefore, while it is possible to make an absolutely uniform cement by the wet process, it is not so easy to do so by the dry. To

avoid variable cement it is true that a mixing system for the cement itself can be installed, but this complicates the plant unduly and adds considerably to the cost of upkeep and production. In this connection it might reasonably be assumed that, from the point of view of upkeep, the advantage will lie with the wet process, which employs pumps or slurry elevators and gravity to handle the slurry, as these are more easily maintained than elevators and worm conveyors and raw-meal pumps dealing with the dry powder on the other system.

When the mixture reaches the kiln in the form of slurry, containing from 32 per cent. to 45 per cent. or more of water, or even when de-watered slurry with from 16 per cent. to 20 per cent. of water is used, there is no danger that the calcareous and argillaceous ingredients can separate, even to a small extent, and the right proportions of these ingredients will exist together in intimate proximity as they travel down the kiln until chemically combined. With the dry method there is a danger that the draught of the kiln gases meeting the entering raw meal may cause a disturbance, and re-distribute the ingredients, and the calcareous content may become too high in one place, while it is too low in another. This difficulty may be obviated to a considerable extent by damping the meal as it enters the kiln, but the danger is there. At one works known to the writer, where coolies are employed to watch the introduction of the raw meal into the kiln, about 10 per cent. of water is added to the dry powder. The coolies know that damped meal has a tendency to stick in the kiln feed-pipe, so to save themselves the trouble of clearing the pipe at night, they frequently turn off the supply of water and an absolutely dry powder is fed to the kiln, greatly increasing the danger of separation.

Nowadays, the use of quick-hardening Portland cement is becoming more general, and there seems little doubt that an increasing proportion of this variety will be demanded as time goes on. The manufacture of quick-hardening cement is, therefore, becoming more and more important; in this case even greater care must be exercised in the control of the mix, and the wet process shows to greater advantage. It is not easy to make a uniform quick-hardening Portland cement by the dry process, especially where reliance must be placed on native labour.

In your leading article in the October issue, it was stated that the power required for manufacturing purposes was greater on the wet process. This has not been the writer's experience, and in general he has observed that the reverse holds good. As regards the mixing of the raw materials, it is generally true that when using purely mechanical mixers for preventing the slurry from settling and for maintaining its uniform composition, more power per ton may be used than for a simple system of elevators and conveyors handling a dry powder, as is also the case if compressed air is used alone for dealing with the slurry. But if a combination of air and mechanical mixing is employed, such as is frequently found in modern American works, the power bill will certainly be no more per ton of cement than when using an elaborate bin system.

When grinding the raw materials, it is usually found that they are more easily pulverised in a tube mill with water than in the dry state. This will depend upon the physical properties of the materials in question, but, while the reverse

has never been encountered by the writer, he has sometimes found that less power is required for wet raw grinding. On the cement side the same result may also be found, although this may be owing to the lighter burning generally encountered in the wet process, probably due to more easily ground and therefore finer raw material from the wet mill. About two years ago the writer visited a cement works which had just changed from the dry to the wet process. The plant had a capacity of 4,200 barrels per day. Opportunity was afforded for a complete investigation, and it was found that when using the same clinker grinding mills, the clinker grinding capacity had increased, after the change over, by about 20 per cent.

The dust contained in the flue gases leaving the kiln is an important consideration in Portland cement manufacture. Apart from the loss of material occasioned, the distribution of dust in the neighbourhood may cause a nuisance in many districts, especially in those of a residential nature. It is not possible to give a hard-and-fast rule as to the actual quantity of dust which will be generated on either process, as so much depends upon the raw materials themselves, and the conditions of manufacture at any given plant. But a rough average indicates that the dust generated by a dry plant will probably be in the neighbourhood of 6 per cent. of the raw materials used, while a wet plant will give considerably less, without elaborate precautions for dust precipitation being taken in either case. That is, in a works producing, say, 1,000 tons of cement per week, about 96 tons of dust per week will be generated on the dry method. The quantity varies considerably from plant to plant, and in the case of one dry plant known to the writer as much as 10 per cent. of dust was dissipated into the atmosphere. In general, it is safe to say that a dry process works will show a higher percentage of dust in any given case.

It is true that the output per cubic foot of kiln volume is greater on the dry process, and a dry-process kiln for a particular output will be less expensive than the corresponding wet kiln. But against this additional capital expenditure on the wet process, dryers will be required for the raw materials on the dry system. and in the end there will be little either way in overall cost of plant. As regards the fuel necessary for calcination, a modern dry kiln will consume about 20 tons of coal for each 100 tons of clinker manufactured, assuming coal of standard calorific value containing 12,600 B.Th.U.'s per pound. To arrive at an overall coal consumption (not including power), we must add to this figure the coal required to dry the raw materials, which will vary with the percentage of moisture in the materials. A modern long wet kiln, furnished with special arrangements for dealing with the slurry and for cooling the clinker, will use about 24 tons of standard coal to burn 100 tons of clinker, when the slurry does not contain more than 40 per cent. of water. This may leave a balance in favour of the dry plant, but when the extra coal probably necessary for power generation for dry grinding is taken into the calculation, it is doubtful whether the dry process can show much advantage.

So far the balance undoubtedly lies in favour of the wet process, but when we consider the question of power generation the dry process shows to much greater

advantage, whatever the future may hold for the wet process using filtered slurry. When burning normally and using, say, 21 per cent. of standard coal per ton of clinker, the flue gases from a dry kiln will contain more than sufficient heat to generate all the power required to run the works, provided proper arrangements are made, especially in the flues, to prevent the infiltration of cold air between the kiln and waste-heat boiler, and an economical prime mover is employed. The writer has confirmed this statement at a number of works in the United States, where ample opportunity was afforded for a thorough investigation. On the other hand, when using a long wet kiln with special slurry drying arrangements in the upper end, such as chains, the temperature of the escaping gases, at between 375 deg. F. and 475 deg. F., is too low to allow the use of a waste-heat boiler, Therefore, in addition to using, say, 24 per cent. of standard coal per ton of clinker in the kiln, a further, say, 12 per cent. of fuel per ton of cement must be used for power production. Thus at the present time, while the overall fuel bill on the dry process with waste heat boilers should not exceed 21 per cent. per ton of cement, that for the wet process, under the best conditions, will amount to something in the neighbourhood of 36 per cent.

The future holds a promise of better fuel consumption for the wet process, if the present experiments in connection with slurry filtration prove a commercial success. At several works in the United States, slurry is being filtered to a greater or less extent, but so much depends upon the nature of the raw material handled that so far the method can hardly be said to be more than experimental. If, however, slurry can be filtered from 38 per cent. or 40 per cent. moisture down to, say, 20 per cent., it will be possible to attach a waste-heat boiler to a wet kiln, and, when using only that amount of fuel in the kiln actually necessary for clinkering purposes, to obtain sufficient heat in the flue gases to generate most of the power required on the works. Waste-heat boilers are attached to wet kilns using normal unfiltered slurry, as is well known, but fuel additional to that actually required for burning must be used in the kiln to boost the flue temperature to something in the neighbourhood of 1,100 deg. F., at which temperature there is sufficient heat for power purposes. This is bad practice, and tends to make the object of the rotary kiln the production of steam rather than its proper function of producing clinker, and it may bring the burning of clinker too much under the control of the man in charge of the power plant.

If fuel is very cheap the other advantages of the wet process will probably be sufficient to decide a particular case in its favour, but this is not often the case, and the difference in overall fuel consumption is so marked that, unless some special considerations intervene, such as the nature of the raw materials, very low fuel cost, or poor quality labour, the dry process seems bound to receive favourable consideration.

A short time ago it could have been said that the control on the wet process was so much better that the quality of the cement produced on this method was such that it out-weighed even the difference in fuel costs. But to-day, newer methods of control of the dry raw powder, although still difficult when using poor labour, make it possible to say that a uniform high-grade cement of a

quick-hardening nature can regularly be produced by the dry process. So to-day the dry system has the advantage, but it must be remembered that this is entirely on account of the fuel consumption, for other considerations are certainly in favour of the wet process. With the success of slurry filtration, which may not be far ahead, it is probable that the balance will again be in favour of the wet process.

The Late Mr. S. G. Robinson.

BY the death of Sydney Greenwood Robinson on January 4 in Delhi, India, the cement industry and the machinery industry connected therewith have lost an able and prominent figure.

Born at Leeds 55 years ago, second son of the late Thomas Burley Robinson, he served his apprenticeship and finished his engineering education in his native town. Early in his career he came in touch with that branch of the engineering industry which designs and supplies machinery to the cement industry, and from 1901 till his death, Mr. S. G. Robinson was connected with the well-known firm of F. L. Smidth and Co., of Copenhagen and London, as chief of their London office. It was on a journey in India, in his firm's interest, that he met his death.

The Late Mr. S. G. Robinson.

It was largely due to Mr. Robinson's initiative that the Tunnel Port and Cement Co., Ltd., was formed in 1911. Not only did he take an active part in the formation of the Company, but he served as a Director until his death. Mr. Robinson was thus connected by the closest possible bonds with the cement world, and it is not too much to say that everyone who is in touch with that industry knew and respected him for his great experience and exceptional knowledge of the ramifications of the industry at home and in all parts of the world.

Whenever Dominion, Colonial, or foreign cement people came to London they rarely missed calling at his office in Victoria Station House, and many are those who have benefited by his advice, technical or financial. His open and pleasant manner and genial personality won him friends wherever he went. He will be missed by many.

A Modern Portland Cement Factory.

THE HOLBOROUGH WORKS, KENT.

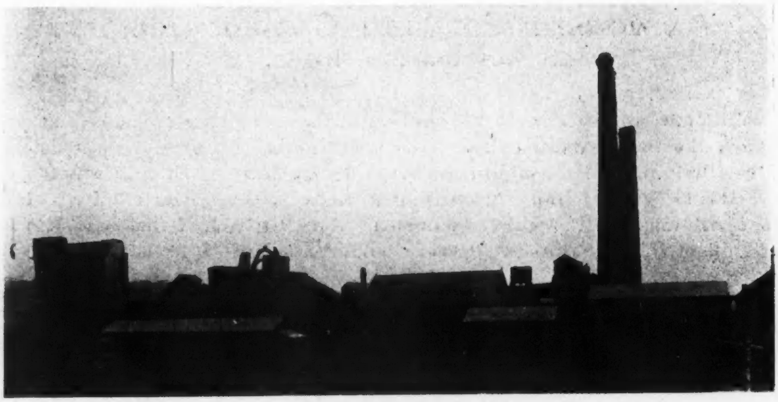
THE "Holborough" works of the Holborough Cement Company, Ltd., was erected four years ago in an area renowned for the quality of the cement produced, i.e. the Medway Valley. The plant is one of the most up-to-date in Great Britain, and is equipped entirely with machinery of British manufacture by Messrs. Vickers, Ltd. The output capacity is over a quarter of a million tons per annum. The works are situated on the left bank of the river Medway, at a point midway between Rochester and the village of Aylesford. Labour-

Aerial View of Works.

saving devices of the most modern type are everywhere installed with a view to reducing costs to a minimum.

An asset of the greatest importance is the nature and quality of the raw material deposit, a deposit of natural marl some 300 acres in extent being adjacent to the plant. The marl deposit is, as quarried from the pit, of such a chemical constitution and physical condition as to be eminently suitable for the production of Portland cement. The marl is excavated by four steam navvies, each capable of a 3-ton bite at each operation.

The quarried material is dumped into rail cars, railed to the opposite side of the quarry, and tipped into a battery of rough or primary washmills of 30-ft. diameter and capable of washing 150 tons of marl per hour. These primary washmills are fitted with slotted sieves having apertures of 5/64 inch The slurry is forced through these grids at the sides of the mills, and is then

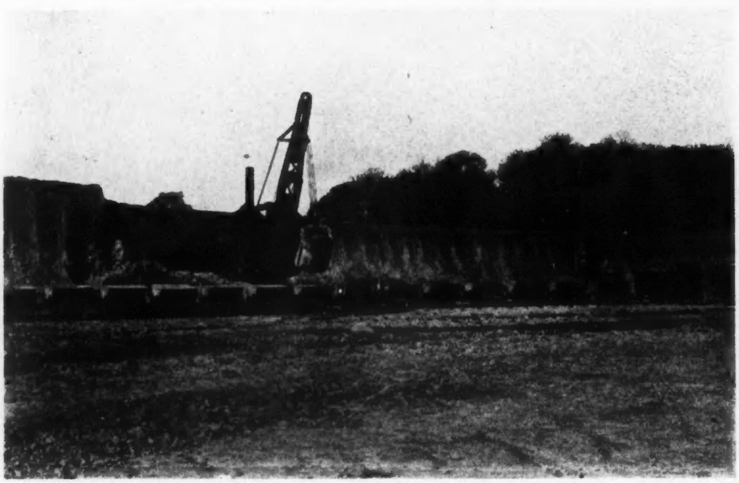


General View of Works.

pumped to a second battery of washmills, which have sieves with openings of 1/50-inch diameter.

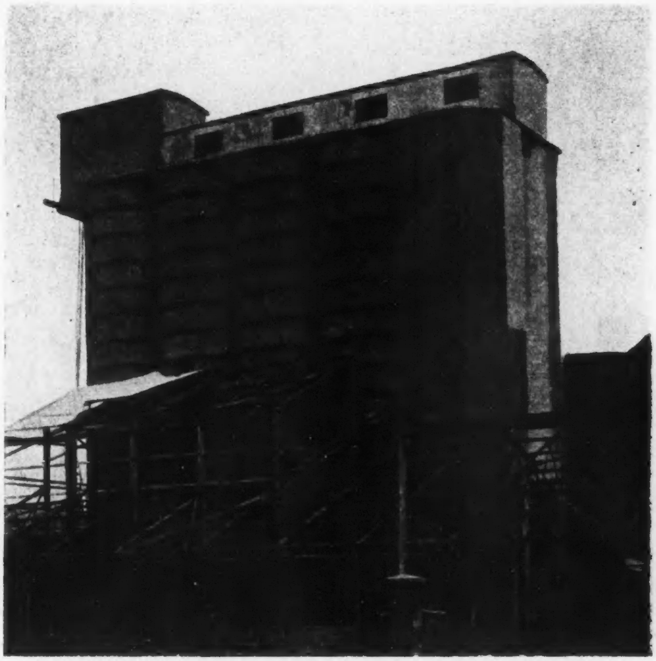
After passing through the sieves of the secondary or finishing washmills, the slurry is pumped to a number of correction and mixing tanks. These tanks, constructed of concrete, are 50 ft. in diameter and have a total capacity of 4,000 tons. The slurry feed presents no unusual feature in the most modern practice, being of the usual spoon-feed type.

The kilns are 200 ft. in length by 9-ft. diameter through the drying zone and



Steam Navvy Loading Tip Train in Quarry.

enlarged to 10 ft. in the burning zone. Induced-draught fans, driven by 40 H.P. Crompton motors, increase the kiln output in addition to enabling a smoother control of the burning to be maintained. The kilns are driven by 60-H.P. slip-ring motors and have a total weight of well over 500 tons. All are direct-driven through gearing from the motor to the girth ring. A pulverising plant consisting of Raymond mills (supplied by Messrs. International Combustion, Ltd.), including magnetic sets for the elimination of any tramp metal in

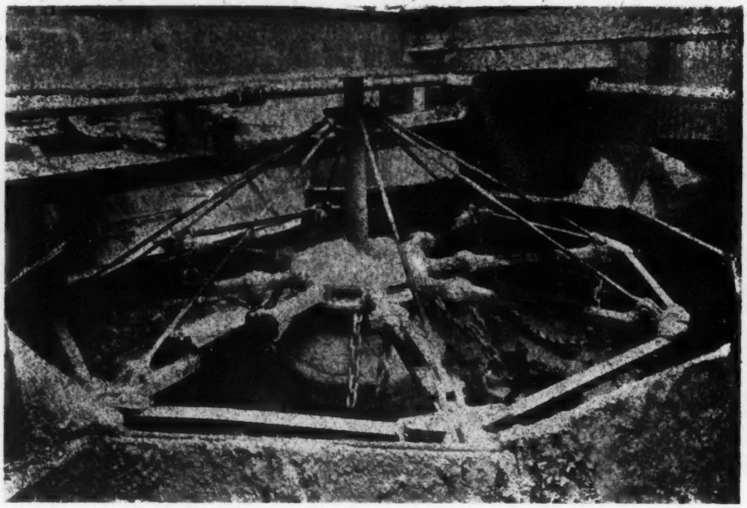


Complete Silos.

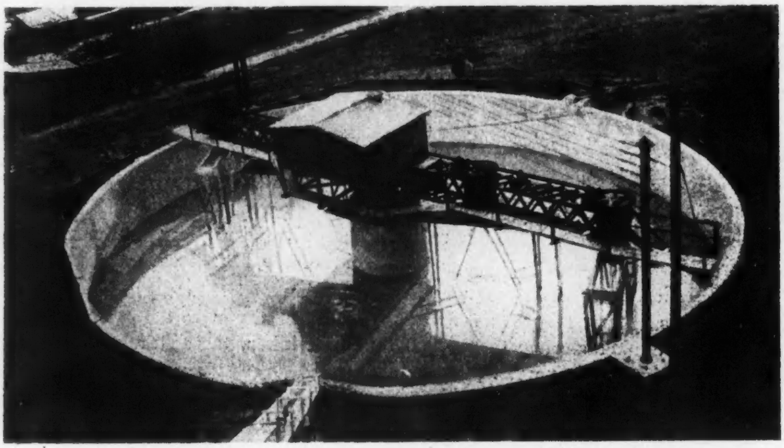
the coal, prepares the coal for burning. The pulverising plant and transference apparatus are situated immediately in front of the kiln hood.

The clinker, after passing through rotary coolers of 90 ft. length by 6 ft. 6 in. diameter, is conveyed by belt conveyors to stock or direct to the grinding mills. There is a clinker storage for 10,000 tons of clinker, these storages being constructed entirely of concrete.

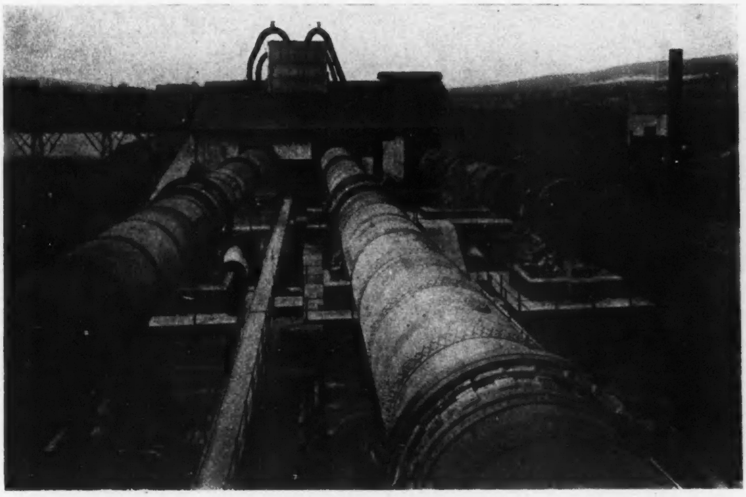
The grinding mills are of the compound tube-mill type, over 30 ft. long by 7 ft. in diameter, and are driven by synchronous motors, each of 600 H.P., driven through machine-cut helical gearing. The mills are divided by slotted diaphragms into three compartments. They are loaded with approximately 40



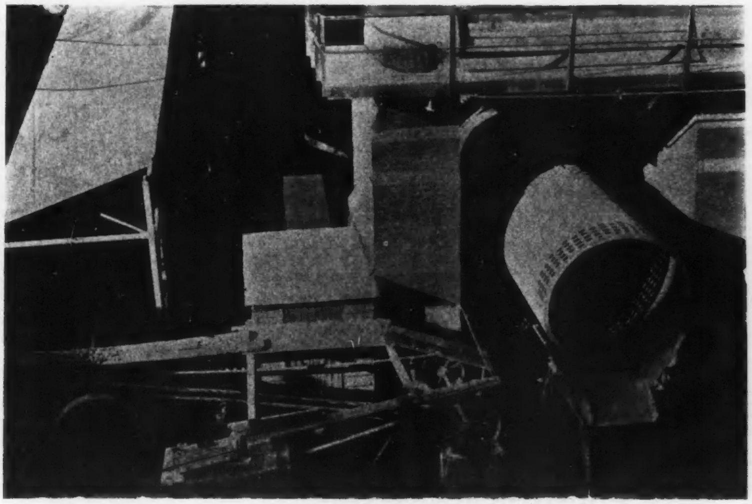
Primary Wash Mill.



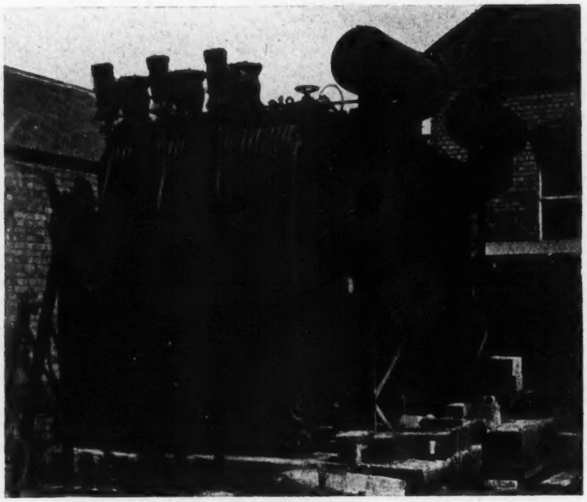
Final Washing Mill.



Rotary Drying Kilns.



Kiln Cooler and Clinker Carrier.



View of Transformers.

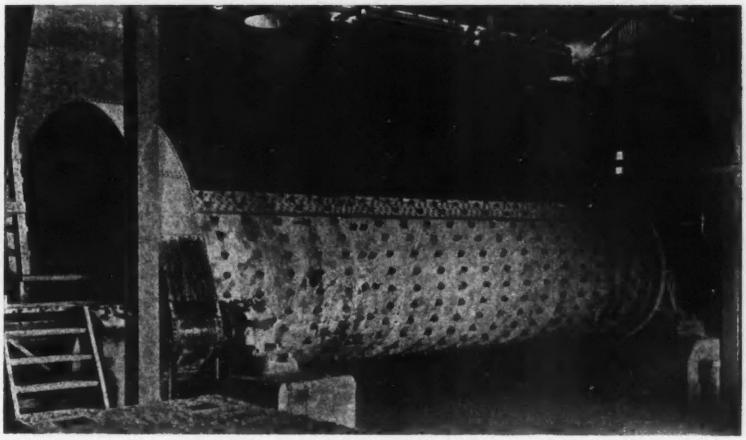
Interior of Power House.

tons of grinding media in the form of steel balls ranging from 4 in. to ¾ in. in size.

The cement transference machinery including screws, elevators, and inclines are all electrically driven. There is a cement storage capacity of 15,000 tons; these storages, as in the case of the clinker storages, are constructed entirely in reinforced concrete, as also are all elevator casings, stages, etc.

The cement storage consists of several batteries of the modern silo type, with packing and loading equipment. The Bates' packers have a capacity of 250 tons per shift. Excellent facilities exist for packing the cement on rail, road or waterside loading stages; 400 tons a day can be despatched from the road loading stage alone. Railway sidings connect direct to the main line of the Southern Railway.

A wharf with 700-ft. frontage enables ten barges to be loaded at the same



Grinding Plant.

time. The wharf, and the permanent way to it from the factory, are electrically lighted, and cement loading goes on night and day.

Coal is delivered direct from the Southern Railway to the coal plant, thus keeping handling costs to a minimum. The coal conveyor is of somewhat unusual design, as far as its use in cement works is concerned; the coal plant as a whole is claimed to be of the most efficient in the industry.

A total of 3,000,000 bags of cement are handled at this plant in the course of a year, and improvements are now being effected or are planned with a view to still further reducing production costs. The whole of the plant is electrically driven, the power being transmitted from Barking at a pressure of 33,000 volts, by means of underground cable. This is transformed down to 440 volts at the plant sub-station. The social side of the lives of the workers is not neglected, and arrangements are in hand for welfare and social care, including sports grounds, etc.

The "False Setting Time" of Cement.

CONTRIBUTORS to the October and November numbers of this journal have commented on the so-called "false set" of cement, by which is meant the stiffening of a paste of water and cement which occurs a few minutes after mixing with some finely-ground cements when the period of mixing is curtailed to about two minutes. This stiffening of the paste is in some cases sufficiently pronounced to prevent penetration of the setting time needles used in connection with the British Standard Specification tests. If, however, the mixing period is prolonged to four or five minutes the same cement exhibits normal setting properties entitling it to be classed as a slow-setting cement.

On one hand the opinion has been expressed that the "false set" is in reality a genuine setting time, and that the inevitable disturbance of this setting time, during the mixing conditions that pertain to ordinary concrete work, might lead to the production of inferior concrete. On the other hand, it has been suggested that the "false set" was essentially nothing more than a stiffening phenomenon due to rapid absorption of water by a very finely-ground cement, and that the "false set" might be entirely ignored.

It is now possible to record the results of some tests designed to show the effect upon strength of prolonged mixing of a rapidly-hardening finely-ground cement possessing a "false set." These results are as follows:

Mixing time, 2 minutes: Initial set 8 minutes; Final set 18 minutes.

Mixing time, 5 minutes: Initial set 40 minutes; Final set 90 minutes.

Water used for mixing neat cement, 22½ per cent.

Compression Tests: Six-inch cubes were made of four parts ballast, two parts sand, and one part cement, gauged with 6¼ per cent. of water. The gauging (and filling of the moulds) was done as quickly as possible for one set of cubes, while for another set of cubes the gauging was leisurely and the mix was left for 20 minutes (with occasional stirring) before the moulds were filled. The results were as follows:

Rapid gauging and moulding: 24-hour test, 2,550 lbs. per sq. in.; 7-day test, 5,800 lbs. per sq. in.

20 minutes delay before filling moulds: 24-hour test, 3,100 lbs. per sq. in.; 7-day test, 6,300 lbs. per sq. in.

These compression tests were repeated under the same conditions as before, except that a wet mix was made (9 per cent. of water being used), giving the concrete a slump of 3¾ inches.

Wet mix compression tests:—

Rapid gauging and moulding: 24-hour test, 650 lbs. per sq. in.; 7-day test, 2,975 lbs. per sq. in.

20 minutes delay before filling moulds: 24-hour test, 825 lbs. per sq. in.; 7-day test, 3,850 lbs. per sq. in.

All these results show that the "false set" of certain cements can be disregarded and treated as non-existent without any detriment to the early hardening or the ultimate strength of the concrete.

Electric Driving of Cement Works.

THE cement industry is one which calls for exceptionally careful consideration of power costs, since the cost of power may closely approximate to the cost of raw material and assume a formidable proportion of the cost of production, and because a high proportion of power is required compared with other industries. The general adaptability and facility of electric power called for early consideration in the cement industry, but it was quickly realised that special characteristics would be demanded of all the plant concerned, whether switchgear, control gear, or motors. The conditions of operation in a cement works are entirely distinct from average industrial operation, being much more arduous in both the electrical and mechanical sense than are met with in most other

Fig. 1.

industries, and considerable research has been necessary into the mechanical conditions to design motors—particularly of the larger types—capable of withstanding the exceptional overloads met with in practice.

The same research has been necessary into the electrical design to ensure suitable forms of weather and dust protection, and into forms of insulation most suitable to withstand extremes of exposure, heat, and cold. It is essentially a condition where success depends entirely upon the suitability of the machine, and where the long running hours and the heavy demands made upon the electrical plant make the first cost of the machinery a secondary consideration. More particularly is this recognised because the main portion of the cement process consists of continuous production for 24 hours a day for 7 days a week, and interruption of production is an exceptionally costly matter.

The normal conditions of cement works make them—from the point of view of the supplier—ideal consumers of electricity, and by the selection of suitable machinery they are able to purchase on the most economical basis. The claims to preferential treatment in the supply of electricity can be based upon the following grounds:

(1) High load factor, usually of the order of 90 per cent. and very much greater than most industries.

(2) Long running hours, the average being 7,000 hours per year.

(3) The use of large units with long running hours suitable for power factor correction of surrounding plant. For this service a supply company selling on a kilowatt basis may give rebates.

(4) Where current is purchased on a KVA basis, for similar reasons high or even unity power factor may be maintained.

Fig. 2.

In addition to the economies to be effected in the purchase of electricity, a further source of saving lies in the selection of machinery of high efficiency. One per cent. reduction in the power cost in a cement works is sufficiently important to demand the special attention of designers. Another advantage enjoyed by the cement industry is that practically the whole of their rotating plant is of the constant-speed type, and therefore the fullest benefit can be obtained from the simplest of squirrel-cage motors for all except the larger mill drives.

The electric motor requirements of a cement factory may be roughly divided into three groups, the first and most important of which is that of driving the mills both for finished and wet grinding. In most modern installations the motors are of 650 and 750 horse-power each at slow speeds, generally 158 r.p.m.,

(*Continued on page* 17).

(*Continued from page* 16).

and of the auto-synchronous type. Group two is composed of ordinary induction motors from 250-H.P. downwards, used for washmills, tube mills, and slurry mixers (the larger sizes being of the slip-ring type), and from 30-H.P. downwards of the "Tork" squirrel-cage pattern. These latter machines are being used for conveying plant, coal screws, elevators, silo extractors, etc. Group three is the smallest, and consists of continuous-current motors used for plant requiring variable speed. The current is generally obtained through a motor generator.

In Group one are included the drives for the largest types of grinding mills and in these the conditions are entirely special. The ball mill may require a starting torque of one-and-a-half to twice full-load torque, and for this reason the auto-synchronous type of motor should be adopted, since these motors are

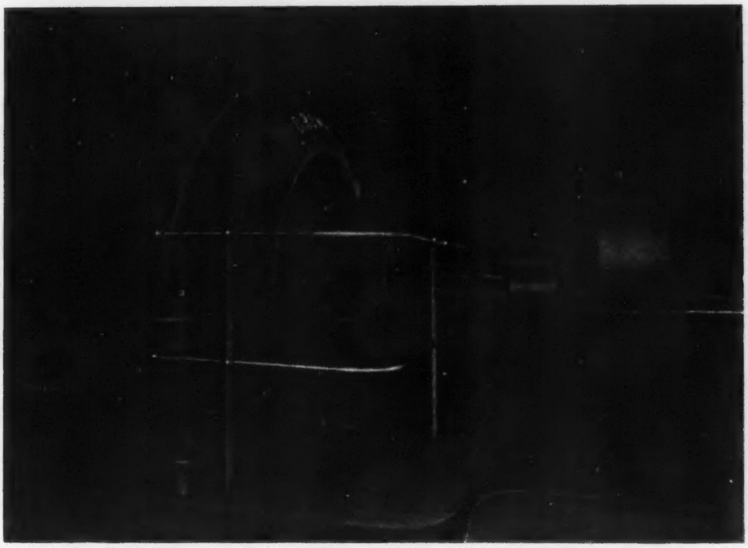


Fig. 3.

usually the units designed to correct the power factor of the remainder of the installation. The ordinary synchronous induction motor would have an insufficient starting torque for this duty, and there is no doubt that the demands of the cement industry have contributed largely to the widespread popularity of the auto-synchronous machines. In practice it is necessary also to have high pull-out torque, as overloads are liable to be met with. To provide these overload facilities it is desirable that the motors should be designed to be automatically self-synchronising, with the advantage that there will be a margin between the machine coming out of synchronism and stalling.

The Crompton auto-synchronous motor has this feature particularly developed, and the machine will continue to run as an ordinary induction motor under

overload conditions of twice full load until such time as the overload is removed, when it automatically returns to synchronism. The slow-speed motor is used direct-coupled to the grinder countershaft, which introduces the single-pinion reduction making a final speed of approximately 20 r.p.m. This method has been found the most satisfactory in practice in this country and favoured in many of the largest cement works.

Continental practice, which has some merit in reduced first cost but which has not received such consideration, employs motors of a higher speed with reduction gear coupled to the mill. Similar conditions apply to the motors for the gyratory crushers and coal pulverisers.

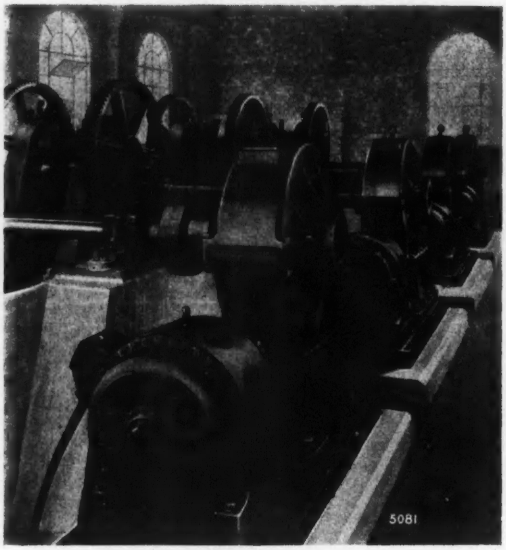


Fig. 4.

Next in importance on the electrical side is the consideration of insulation. Many cement works in this country employ wet grinding and this imposes severe conditions in that the motors are frequently exposed to extremes of heat and damp and the atmosphere is heavily laden with cement dust. These conditions put a very severe strain upon the electrical insulation, particularly as most of the larger machines are wound for high voltages. It is therefore necessary in the contruction of the best type of machine to employ high-tension insulation of the moulded type, carefully protected mechanically.

The auto-synchronous motor, in addition to being capable of a starting torque of from two to two-and-a-half times full load and having a pull-out torque of 175 per cent. full load, can be designed for any leading power factor and correction obtained for the ordinary induction motors used in the remainder of the plant

and/or for plant of neighbouring works by arrangement with the supply authorities.

Probably the most important consideration in maintaining reliability and production in a cement works is the human factor. The labour employed is not usually mechanically or electrically skilled, and it is therefore important that the plant shall be as simple as possible in operation. The starting function should not under any consideration be more difficult than that associated with an ordinary induction motor. The synchronism should be entirely independent of the operator, and should in the case of overload automatically return to synchronism. The Crompton machine has achieved this desirability in its patented connection, and unskilled labour can be readily used to start the motors.

Fig. 1 shows seven stators out of an order for twelve motors having a capacity of 750 H.P. each at 158 r.p.m., placed by the Associated Portland Cement Manu-

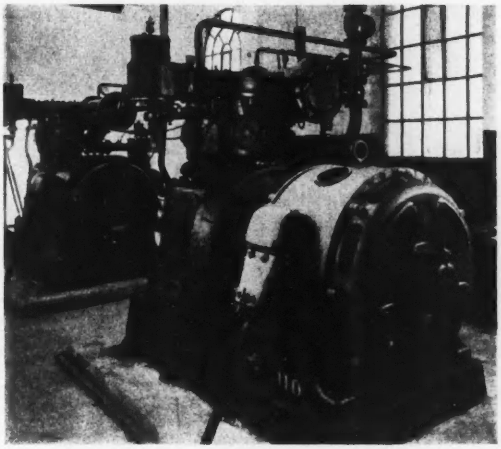


Fig. 5.

facturers, Ltd. Fig. 2 shows five similar machines each driving grinding mills at the Bevans Works of the Associated Portland Cement Manufacturers, Ltd. Fig. 3 is of a 650-H.P. auto-synchronous motor with similar characteristics, which was installed some seven years ago in a Kent cement works. This type of machine is rapidly becoming standard for use in cement work and is being manufactured for use in this country, in all the Colonies, and in America.

In Group two motors are included for the smaller drives. Up to 30-H.P. the ideal machine for most purposes is of squirrel-cage pattern with high starting torque. These machines will cope with 90 per cent. of the applications, and are of the simplest form of electric motor. All machines should be of the ball and roller-bearing type, the housings of which are rendered absolutely dust and moisture proof.

The Parkinson " Tork " motor differs from the ordinary squirrel-cage motor with a high torque characteristic in that, in addition to having high static

torque enabling it to start against severe overloads, it also has a smooth accelerating curve which is often of the utmost importance. Its greatest value is on centrifugal drives where the loads accumulate as the speed increases. In certain cases, where the starting duty is light or friction clutches are employed on the machines, the standard electrical design of squirrel-cage motor will serve, and Fig. 4 illustrates 50-H.P. ball-bearing squirrel-cage motors driving slurry pumps through reduction gear. Fig. 5 shows two 80-H.P. squirrel-cage motors direct coupled to air compressors used for the agitation of slurry in the storage tanks. Fig. 6 is a squirrel-cage motor of the totally-enclosed pattern driving, through gearing, a slurry mixer.

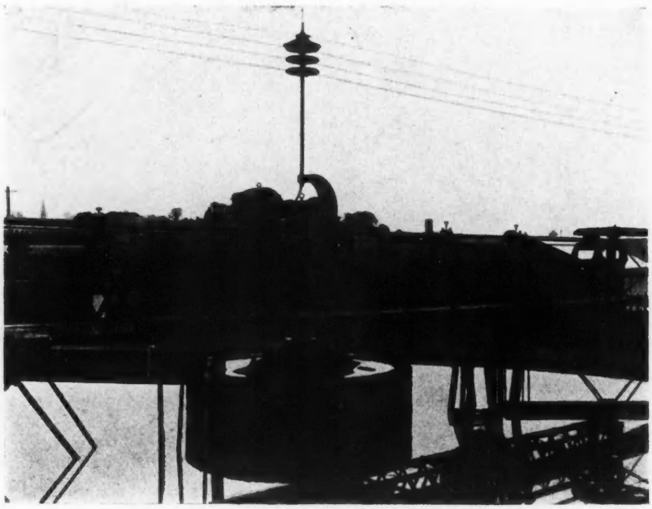


Fig. 6.

Slip-ring induction motors are used in all sizes above 30-H.P. for such purposes as coal pulverisers, small washmills, ball mills, screw conveyors, etc. Similar features in bearings and protection are necessary as with squirrel-cage motors. The slip rings are necessarily enclosed in dust-tight covers. Within recent years a new type of machine known as the Parkinson " Klosd " motor has been developed for these special duties and is being widely adopted.

Fig. 7 shows a slip-ring induction-type machine, the special characteristics of which are that the windings are totally enclosed and surrounded by an outer shell. By means of a fan a draught of air at high pressure passes between the outer shell and the windings casing. By this process a totally-enclosed motor of comparatively small dimensions (in fact, little larger than the ordinary enclosed ventilated machines) is obtainable, and the method of heat dissipation adopted offers improved efficiencies over ordinary totally-enclosed machines.

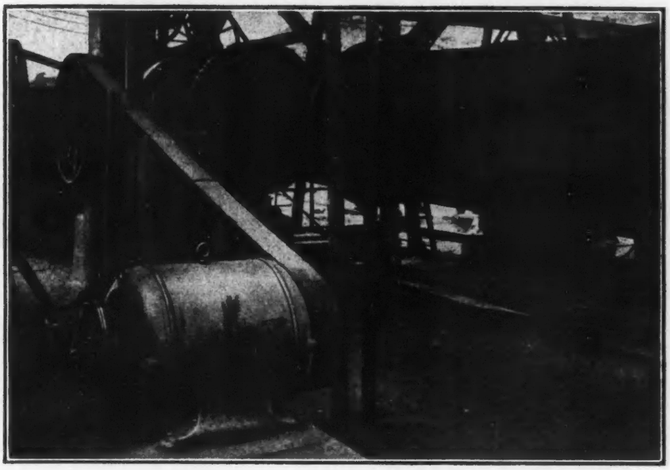


Fig. 7.

This type is ideal for duties in cement works, providing high efficiency, high mechanical strength, absolute winding protection, and complete elimination of dust or moisture from bearings.

Group three consists usually of totally-enclosed continuous-current motors used in certain variable-speed drives. The current is generally obtained from a motor-generator set of the ordinary commercial type, since it can be located in a part of the works protected from unusual conditions. The motors used for this purpose require the same characteristics as the alternating-current machines, i.e. a high margin of mechanical strength, complete protection of the windings and commutator, and high efficiency. Speed control is usually by shunt regulator with a ratio up to 3 to 1.

For these notes we are indebted to Messrs. Crompton-Parkinson, Ltd., of Bush House, Aldwych, London, who supplied the machines shown in the illustrations.

New Companies in France.

" Soc. Financiere des Ciments et de l'Industrie " is a new company formed for the purpose of financing cement and building material undertakings, with a capital of Frs. 50,000,000 (£400,000). The directorate is chiefly composed from the board of Messrs. Poliet & Chausson.

Soc. Ann. de Ciments Portland de Lorraine, has converted itself from a Company under local (presumably German) regulations to a " Société Anonyme " under French laws. The Company only lately received financial assistance from a local financial group (Wendell et Cie.) and the Lafarge interests.

New Dutch Specification for Portland Cement.

THE new Dutch Standard Specifications for Portland Cement, Iron Portland Cement and Blastfurnace Cement contain the following: *Definitions*:—Portland cement is defined as an hydraulic cement containing not less than the following proportions by weight:—1.7 CaO to 1 soluble $SiO_2 + Al_2O_3 + Fe_2O_3$, made by finely grinding the raw materials into an intimate mixture of correct proportions under constant chemical control until the correct composition is obtained, burning until sintered, and finally grinding together with the requisite admixture, if any, to control the setting time.

Iron Portland cement is an hydraulic cement consisting of at least 70 parts by weight of Portland cement clinker and for the rest of granulated basic blastfurnace slag. The constituents are finely ground together with the admixture, if any, controlling the setting time, under constant chemical control. The slag used must be exclusively blastfurnace slag constituted as follows:—

$$\frac{CaO + MgO}{SiO_2 + Al_2O_3} > 1.$$

Blastfurnace cement is an hydraulic cement consisting of 15-69 parts by weight of Portland cement clinker and for the rest of granulated, basic blastfurnace slag. The constituents are finely ground together under constant chemical control, together with the admixture, if any, controlling the setting. The slag used must be exclusively blastfurnace slag constituted as follows:—

$$\frac{CaO + MgO + \frac{1}{3}Al_2O_3}{SiO_2 + \frac{2}{3}Al_2O_3} > 1.$$

The proportion of MnO must not exceed 5 per cent.

Chemical composition:—For all three cements the proportion of constituents insoluble in hydrochloric acid should not exceed 3 per cent.; for Portland cement the proportion of magnesium and of sulphuric anhydride should not exceed 5 per cent. and $2\frac{1}{2}$ per cent. respectively. (The percentages refer to weight of cement dried for 90 min. at 100° C.).

Setting Time and Soundness:—The initial set for neat cement is not to take place before 1 hour after mixing. The le Chatelier tests are used for soundness; the maximum permissible expansion is 10 mm.

Fineness:—The residue on a 900-mesh sieve may not exceed 2 per cent. for each of the 3 types of cement, and on a 4,900-mesh sieve may not exceed 20 per cent. for Portland cement and iron Portland cement, and 12 per cent. for blastfurnace cement (these percentages refer to cements dried for 90 min. at 100° C.).

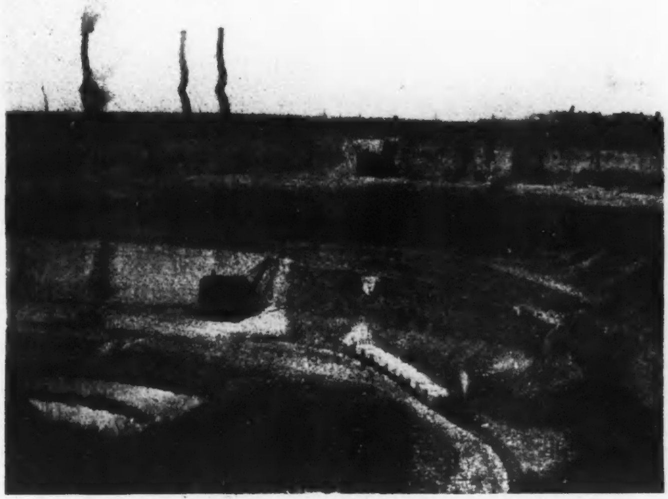
Strength Tests:—For tensile and compressive strength tests, each type of cement is divided into two classes, *i.e.* ordinary cement and rapid-hardening cement. The required minimum strengths for cement mortar (1 : 3 by weight) cured for 1 day in damp air and for 2, 6 and 27 days in water, are specified and are identical for each class of each type of cement. The Böhme apparatus is used in these tests.

Raw Materials for Portland Cement Manufacture.

By A. C. DAVIS, M.I.Mech.E., M.Inst.C.E.I., F.C.S.
(Works Managing Director, Associated Portland Cement Manufacturers, Ltd.)

ANY raw materials, the constituents of which will yield by calcination the silicates and aluminates of lime which form its chief components, may be used for the manufacture of Portland cement.

Lime, which is usually in the form of carbonate of lime (such as chalk and limestone), silica, and alumina are the raw materials necessary for the manufacture of Portland cement, and the latter are generally found in clay or shale in a combined form. Marls, calcareous tufa, blast-furnace slags, alkali waste, etc.,



Excavating Chalk.

also contain indefinite proportions of lime, silica, and alumina, and these materials are also used in cement manufacture, although only to a very small extent.

In manufacturing such cements as are not included in the category of "Portland" cement, *i.e.*, aluminous cement, the constituents are chiefly an aluminate of lime made up of about 40 per cent. lime, 40 per cent. alumina and 20 per cent. silica, iron oxide and other ingredients, the raw materials used being chalk or limestone and bauxite. On the other hand, pozzuolanic cements, once used by the Romans, but not now adopted in the United Kingdom—although used

elsewhere—consist sometimes of volcanic tufas, which are of a porous open-grain structure, mixed with slaked lime, and these produce a durable cement used by the ancients for their gigantic building constructions.

These pozzuolanic materials alone do not produce a cement; the presence of a cementing addition is a necessity, while the activity of the ground volcanic material depends on the presence of soluble silicic acid or hydra-silicic acid which readily enters into combination with the lime hydrate. For this reason any material furnishing silicic acid readily available for reaction with a strong base such as lime may be used for cement other than Portland cement. Even dehydrated silicate of alumina, or lightly-burnt clay, will act sufficiently to form with lime hydrate a cement which is sometimes applied practically by mixing brick dust with slaked lime and which results in a kind of hydraulic mortar.

A modern kind of artificial pozzuolanic cement has found application in the shape of a slag cement made from granulated blast-furnace slag ground together with quick lime or lime hydrate. Blast-furnace slag cooled slowly represents an artificial basic material with but slight hydraulic properties. When granulated or cooled quickly in the liquid condition by means of cold water, it possesses the characteristics of a true natural pozzuolana and has considerable soluble or available silicic acid, and when intimately mixed with lime hydrate produces an hydraulic cement.

White hydraulic cement, again, is prepared from kaolin and chalk with silica in some form or other.

In the case of "natural" cements, by which is meant cements made from natural intimate mixtures of calcium carbonate and clay in their occurring geological formation, these materials are burnt, as dug, at a high temperature and produce an hydraulic cement.

Rapid-hardening cement is actually a superfine Portland cement.

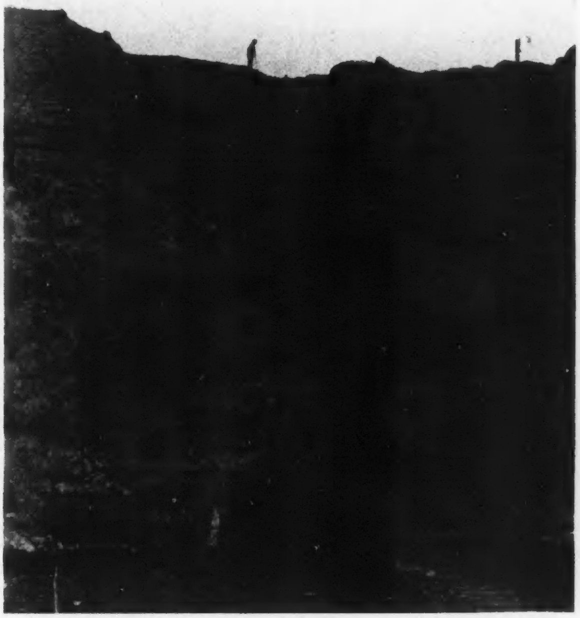
Given the clean carbonate of lime constant as the greater preponderating ingredient of hydraulic cements, the "clay" content can be a complex mixture of minerals, providing its analysis is correct and that there is little free crystalline silica present.

The primary and sedimentary classes of clay, whether kaolins or shales (alluvial or glacial), are all found to be of use more or less provided there is no deleterious content, the choice depending upon proximity of the materials to the carbonate of lime deposit.

In cases where the prevailing conditions demand the addition of silica as such to a Portland cement raw material mixture, and it becomes necessary to look for a silicious material, then such material must be fine or easy to grind to an extremely fine flour if it is to become satisfactory for the purpose; sometimes such materials are made more easily reducible by being heated in a vertical shaft furnace and quenched while hot by a stream of cold water—a good red heat in the kiln being sufficient to accomplish the desired result.

In lias limestone and chalk-marl deposits the necessary ingredients are found in approximately sufficient proportions for cement manufacture in the one

deposit, already naturally mixed, but rarely, if ever, in the exact proportions required. Cements could be made cheaply by the simple method of burning lumps of material as quarried, and then grinding the clinker, if a geological formation uniformly composed, and containing the exact proportions of carbonate of lime, silica, and alumina could be found. There are, however, no such deposits in Great Britain, at any rate in quantities sufficiently large to warrant their use. It has to be remembered that a variation of even one-half per cent. of the amount of carbonate of lime in the raw materials, as well as variations in the other ingredients, will result in inferior quality cement. It is essential that the



"Milling" Chalk by Hand.

raw materials be correct in chemical composition if they are to be suitable for Portland cement manufacture. In Great Britain a percentage of not more than 4 per cent. of magnesium is permitted, and it is essential that free or insoluble silica in the form of chert, flint or quartz should not be present at all, or at any rate only in very small amounts. The proportion of sulphuric anhydride should not be more than 2.75 per cent. While iron oxide and alumina are desirable, if not indeed necessary, for fluxing during calcination, an excess of either of these substances is to be avoided.

From these remarks it will be gathered that the river mud, shale, clay, etc., mixed with the chalk and limestone must be of a silicious nature with as little sand as possible. It is found that highly-silicious clays containing silica up to 75 per cent. will withstand the heat of the kiln without fusing. The result is a slow-setting cement of good quality, the grinding of which is a comparatively simple operation.

It will be obvious that it is not always possible to find on the same site the two principal materials necessary for the manufacture of cement. When such a site is found the success of the manufacturer is practically assured, and all the most successful factories are built on sites where the necessary raw materials are found locally and coal may be obtained at a cheap price.

Whilst it is not absolutely essential that the raw materials should be soft and pure, this is an advantage as it leads to economy in excavating, crushing, and reducing the materials.

The amount of raw materials necessary per annum for a plant using dry materials (such as a mixture of limestone and shale) is about 16,000 tons for the production of 200 tons of cement a week. The total includes about 4,000 tons of shale and about 12,000 tons of limestone. A cubic foot of limestone weighs approximately 160 lbs., so that 168,000 cu. ft. of limestone a year are required to produce 200 tons of cement a week. A cubic foot of shale will contain approximately 125 lbs. of dry material, as shale invariably contains a considerable amount of water; 72,000 cu. ft. of shale will therefore be required each year for an output of 200 tons of cement a week. Thus at least 3,360,000 cu. ft. of limestone and 1,440,000 cu. ft. of shale will be needed for a factory producing a weekly output of 200 tons of cement if there are to be sufficient raw materials available to keep the plant running for 20 years.

In selecting a site for a cement factory, in addition to the supply of raw materials such questions as fuel supply, distance from the principal points where the cement has to be used, facilities for delivery by road, rail or water, have also to be considered.

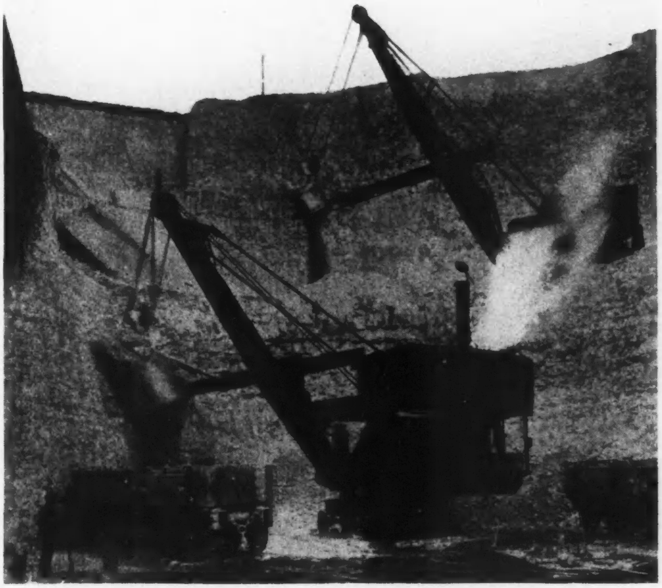
The composition of a prepared mixture of the raw materials should be at least and approximately three parts of chalk or calcareous constituent with the balance of clay or argillaceous or other constituent to make up the correct mixture to produce a good quality Portland cement. The analysis of a mixture of raw materials for the manufacture of cement may be, as an instance, somewhat as follows:—

	Per cent.
Carbonate of Lime	76.35
Silica	14.46
Alumina	5.33
Iron oxide	1.69
Magnesia	0.04
Sulphuric anhydride	0.31
Potash, soda, etc.	1.82
	100.00

Great Britain.

Thames and Medway.—The chalk found near the river Thames, in conjunction with Thames mud or clay, were first used in an experimental way for the manufacture of cement so far back as the year 1820, and it was shortly after this date that the first cement factory on the Thames was erected at Northfleet.

A good supply of raw materials suitable for the manufacture of cement is found in the chalk formation of the banks of the Thames and Medway, and the mud in the banks and creeks of these rivers.



Digging Chalk in Two Benches by Steam Navvy.

The following are analyses of these materials:—

	Chalk.	River Mud.
Silica	1.52	65.02
Alumina	.85	19.74
Iron oxide		7.22
Carbonate of lime	96.45	1.52
Loss, etc. (and organic matter)	1.18	6.50
	100.00	100.00

White chalk, containing about 18 per cent. of water, on the Thames, and the grey or lower chalk underlying the white chalk in the neighbouring hills of the Medway, for a long time were the only materials used, together with clay, in cement manufacture. Most of the clay found by the Thames and Medway is

alluvial mud reclaimed from the banks of the estuaries. On the Thames the mud is obtained from what are known as "saltings."

The Thames and Medway deposits of chalk are anything from 100 to 300 ft. deep. Mechanical plant is invariably used for excavating it, and locomotives and trucks are used for transporting it from the quarries to the factories. In some cases the material is washed at the quarries and pumped to the factory.

Lias Limestone Formation.—Manufacturers in the Rugby and South Wales districts where Portland cement is made use the lias formation of limestone and shale which has to be very accurately handled on account of the thin layers in which it occurs, and the great variation in its composition. In other parts of the country similar deposits are found, but in most cases the proportion of shale is so much greater than the limestone that the cost of operating these deposits would be excessive; in many cases the limestone contains from 80 to 85 per cent. of carbonate of lime.

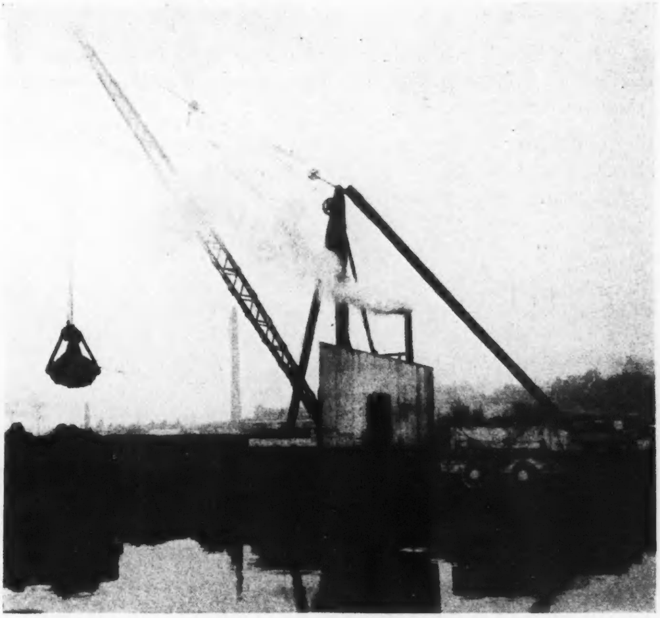
In the Rugby and South Wales districts good quality Portland cement is produced from these raw materials, which are sometimes used dry for the preliminary mixing to the necessary percentage of lime-carbonate.

As a rule the thickness of the shale beds is considerably more than that of the limestone. The layers of impure limestone vary in thickness from 2 in. to 2 ft. or more, separated by seams of shale or clay comprising the lias formation. In the following table analyses are given of the lias limestone and shale:—

	Limestone.	Shale.
Silica	7.81	30.05
Iron oxide	1.90	10.70
Alumina	2.59	3.35
Carbonate of lime	84.37	46.88
Carbonate of magnesia	1.72	3.68
Alkalies and loss	1.61	5.34
	100.00	100.00

Cambridgeshire.—In the neighbourhood of Cambridge a deposit of chalk marl consisting of calcareous and argillaceous material already mixed is found below the local chalk, its principal variation from the chalk above it being in the quantity of clay it contains. It is interesting to note that although the relative quantities of chalk may vary throughout the depth of the face of the quarry it is found that the proportion of calcareous and clayey matter is in the aggregate about the same as is obtained in the Medway valley by mixing chalk with alluvial mud. In the most favourable conditions this deposit is situated some 2 ft. below the surface, and extends to a depth of from 30 to 60 ft. Various analyses show that the quantity of chalk in the deposit averages from 70 to 80 per cent. of the total, while it is rather remarkable that the amounts of silica, alumina and oxide of iron forming the remainder of the deposit are in exactly the right quantities required for making cement. It will be realised that a deposit such as this has to be treated carefully, and as a matter of fact what is known as the "lower chalked" marl is blended with the material containing an excess of lime-carbonate producing a working average of about 76 per cent. of calcium carbonate.

So near do these Cambridgeshire deposits approach the correct constituents for cement manufacture that at one time some of the Cambridgeshire marl deposits were used for making "natural" cement without mechanical mixing. The calcareous deposit was burnt exactly as excavated, and the clinker ground. Owing to the unreliable quality of cement produced in this manner it is not surprising that the process was long ago discarded.



Digging Clay in Marshland.

Owing to the freedom from stone and flints Cambridgeshire marls are suitable for mixing by either the wet or dry process. From these Cambridgeshire deposits, when corrected and properly mixed, an excellent cement may be manufactured, equal in quality to the best artificially-made cement. An analysis of mixed raw materials for the manufacture of cement from the Cambridgeshire deposits is given below:—

Silica	15.72 per cent.
Alumina	4.20 ,, ,,
Iron oxide	1.89 ,, ,,
Carbonate of lime	76.60 ,, ,,
Carbonate of magnesia	1.31 ,, ,,
Undetermined	0.28 ,, ,,
	100.00

North of England and Midlands.—On the Tyne, Wear, and Tees, and in the North of England, Portland cement is generally manufactured from chalk obtained in the neighbourhood, mixed with a good clay which contains less organic matter than that used in the south. A good quality cement is made from this mixture.

In Hull the chalk deposits on the banks of the Humber are used with local clays.

In Northamptonshire the oolite limestone and lias clay, which are sometimes superimposed one above the other, are used as raw materials.

Scotland.—Near Edinburgh a deposit of comparatively pure crystalline limestone is mixed with lower grades of stone, and at other Scottish works blast-furnace slag and limestone are used as raw materials.

Ireland.—A deposit of indurated chalk (locally termed "limestone") is employed near Larne for the manufacture of cement, and is intimately mixed with clay dredged from Lough Larne.

	Limestone.		Clay.
Silica	0.85	...	49.47
Alumina	0.51		14.66
Iron oxide			6.81
Calcium carbonate	97.86	Lime	6.35
Magnesium carbonate	0.70	Magnesia	3.02
Alkalies and loss	0.08	...	2.78
Loss on ignition	—	...	16.91
	100.00		100.00

These descriptions cover the most important deposits of cement raw materials in Great Britain.

Europe.

France and Belgium.—In France chalk and clay are the raw materials generally adopted, while in Belgium a low-limed limestone is used in abundance.

Germany.—In Germany bluish-grey and white limestones and marls are used. In some parts of the country the raw material consists of argillaceous limestone from the Muschelkalk deposits, which in parts are hard and dark coloured, and also very shattered, and contain on an average about 91.26 per cent. of carbonate of lime. The clay used is of a gault variety.

Spain.—There are in Spain abundant supplies of raw materials, which in parts are almost unique, comprising a calcareous loam, homogeneous and containing 72 per cent. calcium carbonate, and also an amorphous carbonate of lime in the state of a very fine powder containing 97 per cent. of calcium carbonate. In some parts of Spain the raw materials consist of a hard crystalline mountain limestone, both pure and low-limed, to which it is sometimes necessary to add sandstone and clay to provide the necessary silica and alumina content to the pure limestone. Trass, volcanic ash, and scoria are also found and used in Spain for the manufacture of a pozzuolanic cement.

Denmark.—A soft chalk without flints is found here with about 98 per cent. $Ca\,CO_3$. Alluvial clay from saltings is used in conjunction with this clay.

Dalmatia.—Large deposits of marl exist all along the Dalmatian coast, the vast majority of them being practically washed by the sea itself. The outstanding feature of these deposits is that the quality of the marl is so comparatively regular that it is often burnt without any preparatory treatment. The value of this raw material for the manufacture of cement lies in the fact that it is a natural mixture of clay and limestone, containing about 75 per cent. of carbonate of lime and over 20 per cent. of clay, but the natural analyses limit the quality of the resulting cement unless carefully proportioned before mixing.

The following are analyses of typical samples :—

	Light.	Dark.
Silica	13.06	12.46
Alumina	5.73	5.93
Ferric oxide	1.13	0.93
Lime	41.71	41.93
Magnesia	1.28	1.39
Sulphuric anhydride	Nil	Trace
Loss on ignition	36.32	36.40
Alkalies undetermined	0.77	0.96
	100.00	100.00
Calcium carbonate	74.48	74.87

Limestones exist also in large quantities, but are sometimes of a silicious nature.

America.

United States.—A great deal of the United States' cement production is from the argillaceous limestone of the Lehigh Valley. This often contains more clay than is desirable for a correct mixture. Usually 10 to 20 per cent. of pure limestone is added to bring the mixture up to the necessary percentage of calcium carbonate. Oyster and sea shells and marl also are employed for the carbonate of lime content.

Canada.—In Canada and British Columbia the high and low-limed hard limestones and marls are similarly used.

Mexico.—Extensive deposits of clay and crystalline limestone exist in Mexico. and the following are typical analyses :—

	Clay.	Limestone.
Silica	46.38	3.20
Alumina	15.90	1.55
Ferric Oxide	4.00	0.80
Lime	11.90	51.90
Magnesia	3.98	1.14
Sulphuric anhydride	0.41	1.48
Loss on ignition	14.80	39.85

India.

Extensive deposits of limestone are found in India of very suitable composition, so that no further addition of argillaceous material is needed for cement manufacture. This stone is classified into two varieties : one variety contains calcium carbonate between 78 and 86 per cent. and is known as " high limestone," and

the other contains calcium carbonate between 70 and 77 per cent. and is known as " low limestone." Typical analyses of the two limestones are as follows:—

	High Limestone.	Low Limestone.
Loss on ignition	38.56	32.76
Insoluble matter / Silica	8.48	22.08
Iron Oxide / Alumina	3.88	4.48
Lime	46.66	39.71
Magnesia	2.02	0.94
	99.60	99.97

Clay is found in very large quantities, but in some places is not used to a great extent owing to the suitable composition of the limestone.

In other parts of the country the silica content of the limestone and clay is insufficient, and this is augmented by the addition of a silicious stone with a typical analysis as follows:—

Loss on ignition	0.80
Silica	69.60
Iron oxide	8.30
Alumina	14.88
Lime	3.30
Magnesia	0.65
	97.53

South Africa.

The deposits of limestone in South Africa vary in texture in different regions. Some consist of a secondary white noduled and concretious limestone, coherent above with soft powdering stone below, with a mixture of white and earthy marl and clay intrusions together with shale lumps and some stones of hard blue limestone with pyrites crystals. In other parts the " limestone " includes a hard and massive tufa. The quality also varies from a silicious material of small value to a limestone of highest purity, of which latter material large quantities exist. The content of magnesium carbonate, however, often varies considerably, ranging from nothing to as much as 30 per cent. in some of the limestone. A friable rufous alluvium is also available. The average percentage of calcium carbonate in the chosen limestone is generally about 76 and of carbonate of magnesia 5. The clays contain an average of 51 per cent. silica and about 11 per cent. alumina, and in places they are found to be low in magnesia. The shale consists of hard silicious stone which is sometimes found to be very low in iron and alumina.

Australia.

Some of the raw materials used in Australia are limestone and marine shales, consisting almost entirely of silica and alumina deposited millions of years ago as the silt of an ancient sea bed. Limestone occurs in great deposits in parts of Australia, but in many places is not sufficiently pure to be used for cement manufacture. Many of the deposits such as are to be found in Australia were,

(*Continued from page* 32).

by great upheavals of the earth's surface, tilted until practically standing on edge, with the result that what is now the surface was originally the depth of the bed as deposited; this accounts for the great depth to which limestone deposits sometimes extend, but they are also sometimes mixed with intrusions. The quality of the limestone in places is excellent, containing between 93 per cent. and 96 per cent. calcium carbonate. Shale is also available in abundance.

China and Japan.

Excellent limestone and clay are found in parts of China.

In parts of Japan, limestone and clay are to be found as well as natural cement rock, but the quantity of the latter is very small. Natural volcanic materials (pozzuolana) are found in profusion in several parts of the country and are used very generally.

Malay.

In Malay there are plentiful supplies of limestone, clay, and sand, but the stone is principally of a blue magnesian limestone. Occasionally among this material occur patches of good crystalline limestone, but the quantity of magnesia in this varies as will be seen by the following analyses :—

Lime	55.00	51.40
Magnesia	0.29	3.13
Ferric Oxide / Alumina	0.40	0.26
Silica	0.44	0.60
Loss on ignition	43.62	43.50

Some of the limestone found in Malay is highly dolomitic.

In Singapore, coral is used to obtain the necessary calcium carbonate. The clay used for incorporation with the coral is blue-grey estuarine mud.

These are a few instances only of the wide range of raw materials now used in the process of Portland cement manufacture, and they indicate that, providing the correct constituents are found, and that no deleterious matter is allowed to be included, the manufacture of Portland cement depends solely upon the careful and accurate choice and treatment of these materials in the preparation and mixing of the constituents for the preliminary process of the manufacture.

From the foregoing it will be seen that given calcium carbonate and suitable clay, or other substitute, in approximate proportions of about 3 to 1, or lime with silica and alumina in any other form, but accurately proportioned, it is most important that the materials be treated with a complete knowledge of the chemical and mechanical operations of combining them, as this alone can secure the regular manufacture of a reliable product.

As stated, the suitability of the raw materials depends primarily upon the manner of the occurrence of these requisites, the position of the materials with respect to the area in which the cement is to be sold, and fuel supplies, for since with every ton of cement manufactured there will be used nearly half a ton of coal or other fuel, the location of the factory in regard to cheap fuel supplies is quite an important factor.

(*To be continued*)

The Jugo-Slavian Cement Industry.

ALL Portland cement manufactured in Jugo-Slavia is artificial, and is manufactured from marl containing 73 to 78 per cent. of lime carbonate. It is estimated that there are 1,500,000,000 tons of marl in Dalmatia alone. This marl is exported for cement-making purposes in addition to being used by the local industry; Italy is the chief buyer. Exports of marl increased from 8,188 tons in 1920 to 311,309 tons in 1927. Dalmatia possesses five cement factories, all fully active, with a capacity of about 500,000 tons per annum.

Croatia and Slavonia possess three plants, two of which only have been working since the war. One of the two active plants, at Beocin, is claimed to be the largest factory in Central Europe, with a capacity of 300,000 tons per annum. Owing to heavy railway freightage, this plant cannot export in such large quantities as in pre-war years, and output has had to be considerably reduced. The Beocin works is the only works producing Roman cement in Jugo-Slavia.

Serbia has two plants with a capacity of 75,000 tons. Slovenia possesses six small factories, of which only two have been working since 1919.

Bosnia produces about 2,000 tons annually at a very small plant, whilst no cement is manufactured in Voivodria or Montenegro although the geological formation is the same as Dalmatia.

The following table gives production figures of the cement industry in these countries in tons:

	Dalmatia	Croatia & Slavonia.	Serbia	Slovenia.	Total.	No of Plants Working.
1920	111 045	65,000	3,470	23,582	203,097	8
1921	190,712	92,000	14,134	26,357	313,203	10
1922	266,223	115,700	23,859	26,270	433,052	11
1923	279,665	142,000	26,234	25,029	473,027	11
1924	377,516	119,600	30,186	24,640	553,742	12
1925	425,884	125,000	36,404	23,705	612,994	12
1926	431,755	161,000	27,502	23,544	645,931	12
1927	460,500	192,000	35,240	23,000	712,740	12

The estimated capacity of the Jugo-Slavian cement industry is 1,000,000 tons. Increases in demand both at home and from abroad are anticipated, with resulting increased output. Dalmatia can dispose of nearly all her surplus product through the export trade, but other States have to limit their tonnage to 50 to 60 per cent. and depend upon Balkan demands for further outlet.

Imports into Jugo-Slavia are negligible. The home consumption increased from 135,990 tons in 1920 to 395,395 tons in 1927.

Increased Australian Production.

It is reported that the Swan Cement Co. of Australia is proposing to increase its capacity by 50 per cent., bringing it up to about 60,000 tons per annum, in order to supply a concrete pipe plant to be erected in Western Australia.

Notes from Abroad.

Increased Production in Finland.

The two Finnish factories, "Pargas" and "Lojo," are to increase their capacity from 650,000 to 1,100,000 casks per annum.

Reconstruction of Canadian Plant.

We understand the Canada Cement Co. has under consideration the reconstruction of its Hull (Ontario) plant, at a cost of over half a million dollars.

New Works in Belgium.

We understand the "Cannon Brand" Artificial Portland Cement Works Co., Ltd., is proposing to build a new plant at Vellereille-le-Sec.

Machinery for Russia.

Messrs. The F. L. Smidth Co. has secured the order for the machinery for a new cement plant to be erected in the neighbourhood of Tiflia (Georgia).

Aluminous Cement in Germany.

Wickingsche Portland Cement & Wasserkalkwerke A.G. is to erect an aluminous cement plant at Kruppschen Hermannshutte at Neuwied. This will be the first aluminous cement plant in Germany.

Increased German Output.

We understand the Zementwerks "Hellbach" Feldma Co. has enlarged its plant due to the agreement to send 300,000 tons of cement to France on reparation account during the period 1929-1931.

German Factory Purchase in Ireland.

The Wickingsche Portlandzement & Wasserkalkwerke A.G. announce that they have purchased a cement undertaking in Ireland (Dublin).

New Hungarian Factory.

An Hungarian financial group is stated to be about to establish a cement factory with an annual output of 50,000 tons. Rumours are also current to the effect that a German cement enterprise, standing outside the German Cement Cartel, intends establishing a cement works in Hungary with a view to supplying the Balkan markets.

Reported Spanish Cement Trust.

Continental newspapers report the formation of a cement trust in Spain. A central organisation is to be set up to regulate production and conduct sales. The proposals are stated to have the approval of the Government.

Chilian Developments.

It is reported that a Company is being organised locally to manufacture cement in the Polpaico district. Prominent industrialists are interested, and it is stated that 12,000,000 pesos (£425,000) will be subscribed locally.

Amalgamations in France.

Ciments Francais (Demarle Loquety), is reported to be considering the absorption of Societe des Ciments de Daignac, a two-year old, 60,000-ton plant near Bordeaux, and to increase its capital of Frs. 27,000,000 to Frs. 27,900,000 (£216,000 and £223,200) to finance the fusion. The proposed acquisition, it is stated, will better serve the Company's markets in that area and assist in the overseas trade from Bordeaux.

Suggested International Cement Agreement.

It is reported from several Continental sources that negotiations for a world-wide cement agreement are under way. Limited agreements for the division of markets already exist among Germany, Poland, and Switzerland, and between France and Belgium. Austrian and Hungarian cement manufacturers recently reached an accord for the same purpose. We understand it is now proposed to bring all cement-producing countries together in a world understanding. The American cement industry, it is said, has been approached with a view to its participation in the projected entente.

New Machinery for Australian Works.

The new machinery required for the proposed increased capacity of the Railton plant of the Goliath Portland Cement Company, Ltd., Australia, is to be supplied by the F. L. Smidth Co.